

HPR-2(108) TM2-2
States (TX)

TECHNICAL MEMORANDUM

DIAGNOSTIC STUDIES OF HIGHWAY VISUAL COMMUNICATION SYSTEMS

HPR-2(108)

PILOT SITE NUMBER 2

INTERSTATE 30 IN BENTON, ARKANSAS

TM2(108)-2

INTRODUCTION

The "Diagnostic Studies of Highway Visual Communication Systems" research project has been designed to: (1) review the current practices in visual communications with the automobile driver using a multi-discipline team approach; (2) identify the deficiencies in these practices; and (3) recommend changes in the existing standards. Pilot studies were conducted in three states (Arkansas, California, and Maryland) in order to develop the diagnostic study techniques and to acquaint the members of the Project Policy Committee with these procedures. This memorandum is a detailed report on the results of the diagnostic team review of sites within these states. The opinions expressed are those of the diagnostic team and not the recommendations of the research staff. The results of pilot studies and the improvements recommended by the staff will be combined as an interim report to be published in the near future.

DESCRIPTION OF STUDY PROCEDURES

The diagnostic evaluation of the study site was conducted using both the driver interview and the open-end questionnaire techniques. Each member is asked to drive a route following the instructions of the interviewer. The route included short sections on adjacent facilities as illustrated in Figure 1. The driver was asked to comment on the roadway section as he drove, and these comments were recorded. The interviewer asked questions only as necessary to keep the conversation productive. At the conclusion of each driving phase (night and day), the subject was asked to complete a questionnaire. The interviews and the comments on the questionnaire are the basis of the material presented in this memorandum.

STUDY SITE CHARACTERISTICS

Interstate Highway 30 in the City of Benton, Arkansas, is best described as a suburban freeway section with fixed illumination (400 watt luminaires at 30 ft. mounting height). The study section included all of the lighted portion in the City of Benton (i.e., the beginning and end of the section was defined by the first and last luminaire respectively). The study section was approximately 4.68 miles in length and included three interchanges. The development along the frontage facilities can be characterized as moderate to light with little, if any, control of access on the frontage roads.

The basic roadbed consists of a four-lane divided, controlled access freeway with paved shoulders and two-way frontage roads. The interchanges include a wide variety of geometrics and are connected to the freeway by the frontage road. Access to and egress from the freeway is gained by slip ramps to and from the two-way frontage roads.

The freeway through section has an edge stripe, even though a very high contrast between through lanes and shoulder exists. Post-mounted roadside delineators mounted at four feet are in place throughout the study section.

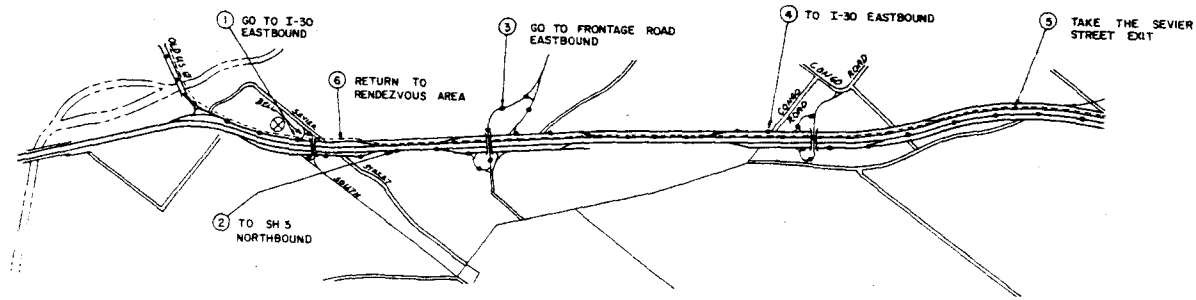
The frontage roads had centerline markings, were partially curbed and appeared to be composed of short sections of varying designs. Where the slip ramp from the freeway intersects the frontage facility, the two-way frontage road had yield control.

Directional signing is located on the right in all instances.

The traffic volumes on I-30 in the City of Benton vary from 13,200 vehicles per day near the west end of the study section to 11,700 vehicles per day near the east end. The average running speed in the study section is 68 miles per hour - the posted speed limit is 70.

The six month accident record (Jan. - June, 1968) shows nine accidents of which four resulted in personal injury. Three accidents involved collisions with sign and/or luminaire supports. Seven accidents occurred on the ramps with six of these occurring on exit ramps. The predominate type of accident was of the "ran-off-the-road" type (or "skid-off-the-road" type). Three rear-end collisions occurred on the exit ramps. Speed was a factor in four accidents, while "driving while intoxicated" was reported in three. One head-on crash between a vehicle entering the freeway on an exit ramp (wrong way movement) and a main line vehicle was recorded. Wet pavement appeared to be associated with five collisions. The apparent accident rate is 89 accidents per million vehicle miles of travel. No fatalities were recorded.

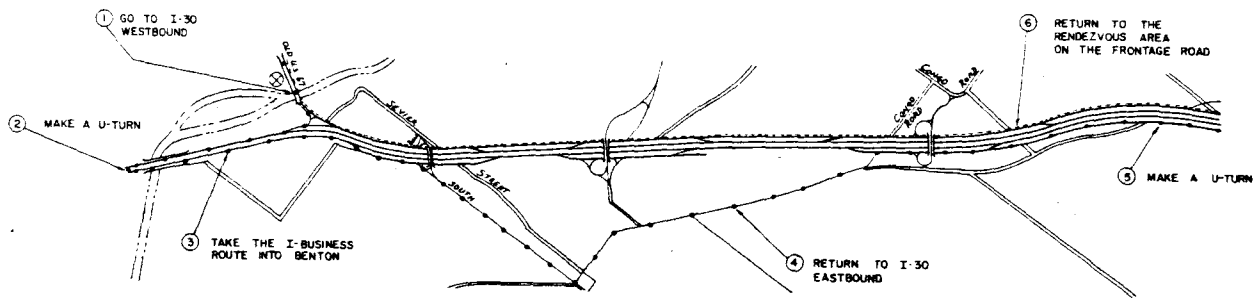
A strip map of the study section is presented in Figure 1. All frontage roads shown are two-way.



ROUTE 1



- - - - - INBOUND
 - - - - - OUTBOUND
 X RENDEZVOUS POINT



ROUTE 2

HPR-2(108)
 PILOT SITE NO. 2
 INTERSTATE HIGHWAY 30
 BENTON, ARKANSAS

STRIP MAP OF STUDY SITE 2 INDICATING DRIVING ROUTES
 FIGURE 1

DIAGNOSTIC TEAM REVIEW

PILOT SITE NO. 2-I-30, BENTON, ARKANSAS

HPR-2(108)

GENERAL

The team review of Pilot Site No. 2 indicated that the design standards of the frontage road and interchange facilities are typical of the early stages of freeway development in this country. In particular, the two-way frontage roads with slip ramps off of the main lanes, the tight two-way loop ramps, and the extremely restricted sight distances entering the cross-road at the terminal of the ramp were of concern to the team members. There was a general feeling that the facility operates successfully at the present time due to the low traffic volume which permits the driver to study confusing situations in detail. With slightly heavier volumes, the accident potential of this facility is tremendous. Consideration should, therefore, be given to converting the two-way frontage roads to one-way operation with the associated changes in ramp design and operation.

SUGGESTED DESIGN IMPROVEMENTS

Many possible design improvements were discussed by the diagnostic team, and four seem to be most important:

1. The use of break-away sign supports and/or moving signs further away from the through travel lanes;
2. The location of the guardrail on the eastbound on-ramp at the Benton State Hospital interchange;
3. The island configuration on the frontage roads, in particular the approach to the Dobson's Bridge at the rendezvous point; and
4. The treatment of the approach to the Saline River Bridge on I-30.

The use of break-away sign supports can be accomplished rather inexpensively and should be incorporated with the suggested signing improvements to be discussed later.

The eastbound on-ramp from the Benton State Hospital interchange terminates in a guardrail at the Saline River Bridge in a forced merge situation. The guardrail at the terminal of on-ramp should be so as to make the transition to the bridge rail more positive.

The length of the on- and off-ramps were of concern throughout the study site and the feasibility of extending the length of the on-ramps should be

explored. Based on past experience, it is doubtful that the addition of a parallel deceleration lane to the off-ramps will substantially alter the operation of the facility.

The island configuration on the frontage roads was confusing to the subject drivers. Both the technical and non-technical drivers reported difficulty in selecting the proper path. It was suggested that the "Y" intersections at ramp terminals be replaced with "T" intersections. A particular point of confusion was the old U.S. 87 (Dobson's Bridge) intersection with the north frontage road. The turn onto old U.S. 87 toward Dobson's Bridge appears to be the major roadway (continuation of the frontage road), when it is in fact a dead-end roadway. Some identification of this fact is required, and it was suggested that the channelization be redesigned in order to make the dead-end roadway appear as a minor roadway intersection with the frontage road rather than a continuation of it.

SUGGESTED OPERATIONAL IMPROVEMENTS

Signing - The most critical problem of signing identified by both groups of subject drivers was the lack of directional signing on the frontage roads. The most notable example was the eastbound approach to the Sevier Street Interchange on the north frontage road. No directional information of any type is provided at this point. In general, it can be said that the signing of the frontage facilities was incomplete and tended to use destination names rather than route numbers. It was suggested that the informational signing on the frontage road be revamped to include directional information to Interstate 30 Westbound and Eastbound at each interchange and on both frontage roads. It was also suggested that cardinal direction plates be added to both the frontage roads and main lanes. Intersecting state highways should also be signed by route number and cardinal direction.

Several drivers reported difficulty in locating the entrance ramp, particularly at night. It was suggested that freeway entrance signs be added at each on-ramp to complement the wrong way signing used on the off-ramps.

The eastbound on-ramp to I-30 at the Congo Road interchange tends to surprise even an alert driver. Advance notification of this ramp should be provided.

The "YIELD" signs located at intersections on the frontage road were very difficult to find both day and night. The signs were too small and located far too high to be effective, especially at night. It was the opinion of the diagnostic team that a "YIELD" sign of standard size be used with a five or six-foot mounting height.

Regarding the main lane signing, four major points were made during the driver interviews and during the review session. These were:

1. The use of "MERGING TRAFFIC" warning signs just in advance of the on-ramp is of questionable value and should be discontinued. Those signs already in place should be removed.

2. "YIELD" signs should not be used at the terminal of an on-ramp. The merging maneuver is a lane change which is effectively covered in the existing codes and can be enforced adequately. The "YIELD" sign does not contribute to safer operations and does create another hazard in the driving environment.
3. The direction sign to "U.S. 70 BUSINESS" and "I-30 BUSINESS" has an unnecessary message, and "U.S. 70 BUSINESS" is not signed after leaving the Interstate. Consideration should be given to dropping the business designation altogether, and if this is impossible, the "U.S. 70 BUSINESS" indication should be blanked out. If the business loop is to be used, the associated confirmatory marker and trailblazers should be in place and well maintained.
4. The use of arrows on directional signs was also identified as a problem by both groups of subject drivers. The arrows should not be used on advance directional signing. Where it is desirable to convey such information to the driver, a "NEXT RIGHT" or "NEXT EXIT" supplementary message would probably be more appropriate. It was suggested that the arrows be removed on all signs except on "EXIT" signs located in the gore area.

The night interviews indicated that some of the directional signing on the main lanes appeared dead, and it was suggested that either the installation was old or possibly the illumination tended to wash out the sign. Also, there was some discussion on extraneous signing ("NO U TURN," "EMERGENCY STOPPING ONLY," etc.), and there was a general feeling that these types of signs are unnecessary and should be removed.

Pavement Markings - Three primary points regarding pavement markings were discussed by the team. The use of two arrows on the off-ramp might give the driver the impression that there are two lanes of traffic in his direction ahead. It was suggested that only one large pavement arrow be used.

Another concern of the subject drivers was the lack of indication of two-way operation on the frontage road. The only available indication was the center-line, and this did not appear to be sufficient, particularly for a driver coming off the freeway. Both groups felt that some additional information source was required.

The use of the edge line with fixed illumination was of particular interest at this site, as there was a great deal of contrast between the through lanes and the shoulder in the daylight. The illumination provided at night tended to eliminate the shoulder contrast and thus increase the usefulness of the edge stripe. The edge stripe, however, also tended to wash out and thus did not fulfill the delineation need. There was some indication that the edge line was old and had lost some of its original brightness, and this was probably a contributing factor to its ineffectiveness.

Delineation - In addition to the edge line, post-mounted roadside delineators were used on both the through lanes and on the ramps. These delineators were mounted at a height of four feet. The delineators on the main lanes were almost totally ineffective, partially as the result of the fixed illumination and partially as the result of the four-foot mounting height. The delineators on the ramps were effective and of considerable value to the driver at night. The diagnostic team review indicates that continuous roadside delineation is unnecessary with fixed illumination of the type provided at this site (400 watt units at a 30-foot mounting height), as the illumination system provides the desired degree of delineation of the roadway. On the ramps, the post-mounted delineator should be used but should be mounted at 30 or 36 inches to make them more effective on low beam. It was also noted that the design criteria are the same for all situations regardless of the angle of divergency of the ramps. Some can use delineators on both sides, while others can only be effective with delineators on one side.

Illumination - The illumination system used is adequate for illumination of the main lanes but does create some glare problems. The review team members suggested that a glare cut-off be added to the unit to reduce the glare problem. Adding to the glare of the fixed illumination was the glare of headlights and the opposing lanes which produced a considerable distraction for the driver on the two-way frontage road.

The greatest single problem with illumination was the number of luminaires which were out. Several of the burned out units were at critical points on the roadway (tight loop ramps, etc.) and thus made driving the facility somewhat difficult at night.

One of the team members felt that some additional illumination was required and suggested the use of 500 watt units in place of the 400 units. The lack of uniform light distribution was also noted, but no suggestions were made regarding improving light intensity uniformity.

The safety consideration lead to a suggestion that cast inserts be added to each luminaire support in order to reduce the accident potential of the luminaire support.

Numerous glare and distraction sources existed along the frontage roads. Two types were most notable: (1) a flashing sign of any color, and (2) the very intense illumination used on some service station drives, motels, and used car facilities. The control of such distraction is a difficult problem but is also relatively important to the driver. At least the design and traffic engineer must recognize that the driver's ability to process information when exposed to such distraction is greatly reduced, and the simplest possible design or communications system should be used.

The lack of a light transition zone was noted by two of the non-technical drivers. Some sort of stage buildup and reduction of the illumination at the terminal points might be considered.

GENERAL SUMMARY

The most notable feature of this study section was the breakdown of the communication systems upon leaving the main lanes of the freeway. This interface between arterial streets or highways is most critical and should be designed, constructed, and maintained as a unit. Continuity of signing, using the route numbers, should be the primary emphasis in design.

The interaction of illumination and the delineation and informational requirements of a facility were also noted. It would appear that fixed illumination of the type provided in this section is its own delineation system but increases the difficulty in locating unlighted off-ramps thus increasing need for a positive delineation system. Artificial lighting washed out the contrast between the through lanes and the edge line. The contrast is good in the daylight.

LIST OF APPENDICES

APPENDIX "A" - DESCRIPTION OF STUDY PROCEDURE

APPENDIX "B" - SUMMARY OF DIAGNOSTIC QUESTIONNAIRE

APPENDIX "B" - SUMMARY OF TECHNICAL DRIVER INTERVIEWS

APPENDIX "B" - SUMMARY OF LAY DRIVER INTERVIEWS

APPENDIX "A"

DESCRIPTION OF THE STUDY PROCEDURES

The diagnostic evaluation of a study is conducted in four separate phases:

- a. Preliminary session
- b. Day driving phase
- c. Night driving phase
- d. Diagnostic team review

The preliminary session is designed to introduce the interdiscipline team to the objectives of the study and to explain the study procedures. The diagnostic questionnaire is presented to the team and discussed with them. The explanation of the questionnaire concentrates on the fact that it is not designed to obtain a particular response from them, but rather it is designed to direct their thinking into a particular area and thus elicit comments which the individual might care to make.

The day phase of the on-site review begins on the afternoon of the first day of the study. The diagnostic team members are transported to the rendezvous point at one end of the study section. Two cars are used in the driver interviews and, upon arrival at the study site, the number one drivers begin their driving runs with the other team members remaining in a car stationed at the rendezvous point. The driver is given instructions well in advance of the required maneuver, and his comments regarding the communication systems provided are recorded on a portable tape recorder. The comments are tied to the roadway through reference markers located at the roadside. The marker numbers are read and recorded on tape as each is passed. After completion of the driving run, the team member moves to an observer position, and the second driver begins his driving run. A different route is driven by the second driver. Errors made during the driving phase are corrected as soon as it is practical to do so. When both the driver and the observer runs are completed, the team member is asked to complete the diagnostic questionnaire on the daylight phase. The process is repeated until all team members have served as a driver and as an observer.

The night phase is conducted in the same manner as the day phase and is held on the evening of the first day of the study.

The morning of the second day of the study is devoted to a team review of the study site. Problem areas are identified, and suggestions regarding possible solutions are discussed. The team is not asked for a consensus of opinion on the improvements which should be made on the study site. Rather, all ideas are explored regardless of how many or how few of the team members might support them.

The comments made on the diagnostic questionnaire and the summaries of the driver interviews are the basis of the Technical Memorandum on the study site, which is the formal report of the opinions expressed by the team.

APPENDIX "B"

SUMMARY OF DIAGNOSTIC QUESTIONNAIRE

PILOT SITE NO. 2 I-30 BENTON, ARKANSAS

The following is a detailed presentation of the comments made by the diagnostic team members on the diagnostic questionnaire.

Question: Did you, as a driver, lose visual contact with the roadway at a distance less than your desired distance at any point along the vehicle's projected travel path?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x	x	Yes, on frontage roads - No, on main lanes a. Periodically throughout due to roadside development. b. Roadway vertical alignment at all interchanges. c. Multiple "Y" interchanges at all interchanges. Main lane alignment was generally good, while the frontage road alignment ranged from good to poor.
	x		Roadway vertical alignment on frontage road - in particular, the west frontage road south of Congo Road.
	x		Highway structures, ramp termini at ends of overpasses, tight curves on ramps, roadway vertical alignment.
		x	
	x		Roadway vertical and horizontal alignment, 1. Highway 5 interchange loops. 2. North frontage road northbound entrance to I-30 South from Highway 5 hidden.
	x		Highway structures, 1. two-way frontage road roadside development. 2. Ramp interchanges.
	x		On-ramps - Speed: 30 mph.

Question: How would you evaluate the importance of the view of the road, or lack of it, in the driving task?

Answer: (A - of little importance; B - of some importance; C - relatively important; D - critical problem)

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>Comments</u>
		x		Not as important as on a two-lane highway as regards main lanes. At intersections, connecting legs had poor to very poor sight distance in areas of critical importance such as at intersections - on headers - structures.
			x	Sight distance (passing) on two-way frontage road appeared to be restricted at some locations.
			x	Roadway features must be visible, if driver is to relate information received by traffic control devices.
			x	
	x			Too much view. South off-ramp traffic aligned with my travel direction and various other connecting pavements in intersection areas. On the main line, this was of some importance, but diminished from frontage road positions.
			x	Example: An exit ramp should be visible to the driver a considerable distance from the gore. 1500' or so?

Question: Do you, as a driver (observer), feel that the points of divergency from the traffic stream are obvious in time for the normally alert driver to make a smooth, natural transition to the diverging roadway?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x	x	Yes - main lanes, No - frontage road intersections. In all but two cases, advance sight distance to ramps was good. Ramp southbound, south of Saline River was poor. Northbound ramp exiting to Sevier Street (U.S. 70C) interchange was very poor.
	x	x	Yes - entrance and exit ramps from I-30 were satisfactory. No - ramp connections at frontage roads were hard to discern.
		x	The slip ramps are not obvious in some locations.

<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x	Not all - lack of deceleration lane for off-ramps makes detection difficult.
x		
	x	Interchange to state hospital is particularly deceiving. First instinct was an unsureness of whether ramp was left or right of hazard markings.
	x	Substandard design.

Question: Does obscured visibility along the roadway create any noticeable degree of erratic behavior on the part of the driver?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x		Tendency to decelerate in through lane approaching poorly defined points of exit. At all frontage road-crossroad connections, the Y-type intersections caused erratic traffic operation.
	x		Ramp connections with frontage roads, driver was required to slow down - in some cases nearly stop to make the proper movement.
	x		The off-ramp to the hospital is not visible and causes me to slow down and search for it. Also the off-ramp north of the river and to the east frontage road is hidden around a curve.
	x		Slight hesitation.
		x	
		x	
	x		Particularly on the ramps, tight radii on the two-way loops, etc.

Question: Does the driver appear to have difficulty in maintaining the vehicle within the lane (i.e., does he tend to encroach on adjacent lanes)?

<u>Answer:</u>	<u>Yes</u>	<u>Not to any marked degree</u>	<u>Comments</u>
		x	
		x	
		x	
		x	
		x	
		x	
	x		Only on the ramps. This does not happen on the through lanes.

Question: Is the normal traveled-way clearly delineated from parking and emergency stopping areas?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x	x	Yes - main lanes. No - frontage road. Yes - edge stripe - shoulder color contrast.
	x		
	x		
	x		
	x		
	x		
			Possibly.

Question: Does there appear to be any substantial amount of vehicle encroachment of the parking areas?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x		Main lane, No. Frontage road, Yes. Evidence of continuous encroachment along frontage road.
		x	
		x	

<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x	Also shoulder and parking lots.
	x	
	x	
	x	Not noticeably so. I am referring to the through lanes.

Question: (A) Are the roadside hazards (bridge abutments, piers, guardrails, sign supports, etc.) removed a sufficient distance from the traveled-way to insure reasonably safety? (Answer Yes or No) (B) If "NO", is the hazard visible for a sufficient distance to prevent the driver's being startled by it? (Answer Yes or No)

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
B		A	Generally yes; however, narrow bridges without advance delineation (guardrail, pavement markings) introduced some feeling of discomfort. Rigid mounted signs with massive supports represented points of concern.
B		A	Signs should have been moved out or made break-away. Narrow bridge at Saline River.
B		A	
B		A	Yes - except island on old 67 near study point.
B		A	
A		B	Except EB on ramp at state hospital where speed lane taper ends at beginning of guardrail for bridge.
		A	These things do not startle me, but the signs should be set back and guardrail used at bridge piers.

Question: What do you feel is a minimum safe distance from the outside edge of the shoulder to an obstruction _____ feet?

- 20
- 30 Through travel lane.
- 30 Main lanes.

15 Frontage road.
 14
 40
 20 Pavement.
 20 Pavement,

Question: Does the horizontal alignment along the desired path of travel (particularly reverse curvature) require an excessive amount of driver concentration and thus increase the hazard of other roadway appurtenances?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Possibly</u>	<u>Comments</u>
	x	x		No, through lanes - Yes, ramps.
		x		No, as regards freeway lanes, however, on frontage roads, particularly at interchanges, horizontal alignment and geometric configuration of intersections were very poor.
			x	Ramp alignment was restrictive at several locations.
	x	x		Yes, on ramp connections and slip ramps. No, on main line and frontage road.
	x			On the ramps.
	x			This is particularly true of the horizontal alignment of the ramps.
	x			On frontage road. No problem on main line. Particularly acute in maneuvering through interchange areas.

Question: Is there sufficient advance notification of diverging roadways or turn lanes under light to moderate traffic conditions?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x		On main lanes - generally yes, except northbound exit to Sevier Street on frontage roads, signing was incomplete on approaches to and at intersections.

<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x	Directional signs missing - or confusing. Route markers and cardinal direction signs were missing.
x	x	Yes, main roadways - No, frontage roads. The signs often have the wrong message or are nonexistent
x		
	x	Exits from I-30 seemed OK, but notification for people wanting to enter I-30 is weak.
x		Except on frontage roads - lack of driveway control made extremely confusing the proper roadway openings - also main line signing does not follow uniform practice with advance arrow, exit and ramp speed designations.
	x	Not so much on through lanes as ramps.

Question: Is there sufficient advance notification of diverging roadways or turn lanes under heavy traffic conditions (i.e., limited lane change capability)?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Probably</u>	<u>Comments</u>
			x	Difficult to tell since traffic was light to moderate through frontage roads - same comment as 1 above.
		x		
x	x			Yes, on through lanes; No, frontage roads.
			x	Difficulty would be encountered under heavy traffic due to close spacing of interchanges and short ramps.
		x		Same comment as on preceding question.
		x		Under heavy traffic, the comfort factor would be drastically reduced. Due to inconsistency in marking, there would be less margin for error and require additional concentration or communication media other than signs.
		x		

Question: Where lane assignments are indicated, are the assignments clear and easily understood?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x		Main lanes, yes - at frontage road - crossroad intersection, definitely no.
		x	Arrows on ramps - two arrows indicated two-lane. Actually was only one lane onto two-way frontage roads.
		x	The striping on the side roads is confusing. Could do better by using "RIGHT LANE," "NEXT RIGHT" or signs on C.B. separation structures.
	x		Lane assignments were implied right lane for exit. Lack of overhead signing implies this to me.
	x		I am speaking of through lanes

Question: Do the existing lane assignments result in an unnecessary lane change (i.e., indicate a change to another lane when both lanes continue in the desired direction)?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
		x	
		x	
		x	
		x	
		x	
		No answer	
		x	

Question: Is the exit ramp, turning roadway or turn lane clearly identified and outlined?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x		In all but two cases - southbound exit to hospital road south of Saline River and northbound exit to Sevier Street at all terminals or entrances and exits at frontage roads, slip ramp type design presents hazardous head-on condition and enhances possibility of wrong-way entry.
	x		Exits from the interstate were satisfactory. Signing and delineation of the ramps and frontage roads were inadequate.
		x	
		x	Lack of deceleration lane from off-ramps makes detection difficult.
	x		
		x	Most of these conditions are under complete loss and visual contact with the road surface, thus leaving the vehicle operating in the position of "exploring."
		x	Also noticed that the ramp speed signs are located back too far from the nose (some of these signs are black and white should be black and yellow).

Question: When advisory speeds are posted, are they reasonable in light of the downstream geometric and traffic conditions?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
		x	In many instances, exit ramps are too short for easy deceleration to stop condition at frontage.
	x		No posted speed limit was noticed on frontage roads.
		x	No speed signs on frontage roads or connections.
	x		Best under existing geometric design. Possibly advance speed on "exit" gore sign.
	x		

<u>Yes</u>	<u>No</u>	<u>Comments</u>
x		While speed legend was adequate marking of exit, speeds were particularly confusing. They were consistently too close to main lane travel.
	x	But I did not pay much attention to this.

Question: Are directional sign messages clear and concise so as to minimize the possibility of driver confusion?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
		x	Signs faded out in many cases - absence of signs at intersections resulted in loss of continuity.
		x	Some signs were misleading - additional signing is needed in places. Interstate main lane signing appeared satisfactory.
		x	
		x	Some trailblazers missing.
	x		The weakness noted was not the message but the lack of signs in several instances.
		x	Exit direction information was seldom confirmed after leaving the main line. (Example: SR 5 North, US 70 to through S.)
		x	These signs are fair on all the through lanes but very confusing on the ramps and frontage roads.

Question: In your opinion, is the sight distance to right-of-way control devices (signals, "STOP" signs, etc.): (Adequate, Questionable, Inadequate, Critical)

<u>Answer:</u>	<u>A</u>	<u>Q</u>	<u>I</u>	<u>C</u>	<u>Comments</u>
	x		x		Adequate - main lanes, Inadequate - frontage road x road connections.
		x			Some signs were located outside the headlight path
		x			

<u>A</u>	<u>Q</u>	<u>I</u>	<u>C</u>	<u>Comments</u>
x				Some dark spots but does not limit visibility to signs, etc.
	x			
		x		Again, glare considerations limit effectiveness.
			x	

Question: Are the control devices located in positions where they are readily apparent to a normally alert driver?

Answer: Yes, Possibly, Poorly located

<u>Yes</u>	<u>Poss.</u>	<u>PL</u>	<u>Comments</u>
x			Yes as regards main lane operation. Poor as regards frontage roads and x-road connections. There appeared to be over-abundant use of "YIELD" signs rather than "STOP" signs.
		x	Small size "YIELD" signs were mounted too high in some cases - some signs were not located where they were in the driver's range of vision on ramps.
	x		
x	x		Some improvement possible.
		x	Especially when including route destinations and place names. Legends were too small for placement at the locations selected.
		x	Particularly "YIELD" and "STOP" signs on the ramps and frontage roads.

Question: Is there sufficient advance warning of devices which are not readily apparent?

<u>Yes</u>	<u>No</u>	<u>Comments</u>
x	x	Yes, main lanes - No, frontage roads and crossroad connections.

<u>Yes</u>	<u>No</u>	<u>Comments</u>
x		
	x	
x		
x		
	x	Especially on-ramp entrances and turning movements within the interchange areas.
	x	In many cases there is no advance warning on the ramps and frontage road.

Question: Are the required speed changes accomplished in a manner which minimizes driver alarm and discourages rapid deceleration?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
		x	"No man's land" at frontage road - ramp terminals caused alarm. Short ramps required rapid deceleration.
	x		
	x	x	Yes, on through lanes - No, frontage road.
		x	Short deceleration lanes and ramps very abrupt.
	x		
	x		
		x	Tight radii on two-way ramps.

Question: Are adequate speed change areas provided so as to eliminate the need for a substantial speed reduction in the through traffic lanes?

Answer: Always, Usually, On occasion, Seldom

<u>A</u>	<u>U</u>	<u>O</u>	<u>S</u>	<u>Comments</u>
		x		Some ramps were adequate, others were poor.
x				
		x		

<u>A</u>	<u>U</u>	<u>O</u>	<u>S</u>	<u>Comments</u>
			x	
			x	With slip ramp arrangement to two-way front-age road there is a tendency to slow down before exit.
	x			Exception: Westbound at state hospital exit.
	x			

Question: Could sign and/or signal standards be relocated so as to reduce the associated accident potential and still retain an acceptable degree of effectiveness?

<u>Answer:</u>	<u>Yes</u>	<u>Possibly</u>	<u>Probably</u>	<u>Comments</u>
	x			All signs should be break-away and relocated as far as possible from traffic lanes.
	x			
	x			This project needs a complete resigning. Use of separations and possibly on light standards.
	x			Assignment of right-of-way is clearly questionable in my mind. Repositioning existing assignments would be advisable as a 2nd alternate. Double indications and/or longer legends would be appropriate.
	x			But all of these signs cannot be moved out the "magic" 30'.

Question: Where hazard warnings are provided, can they easily be associated with the hazard involved?

Answer: Yes, In some cases, No.

<u>Y</u>	<u>I</u>	<u>N</u>	<u>Comments</u>
x			
x			
	x		
x			
x			
x			

I didn't notice many hazard markers.

Question: Are warnings provided for hazards which are obvious and for which little if any warning is actually required?

Answer: Yes, In some cases, No

<u>Y</u>	<u>I</u>	<u>N</u>	<u>Comments</u>
		x	
	x		Some flashboards located well away from the roadway appear to be of no value.
	x		
		x	
		x	
		x	This area contains minimal warning. I did not sense too much warning at all.
	x		

Question: In your opinion, is there a question as to which traffic stream a right-of-way control device applies? If "Yes" type of device - Location of device.

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
	x		"STOP" signs at side road intersection, Point 9.
	x		"YIELD" signs on ramp - frontage road intersections.

<u>Yes</u>	<u>No</u>	<u>Comments</u>
x		"YIELD" sign at ramp connection with cross-roads - "STOP" sign at highways north and west frontage road.
		"YIELD", Hot Springs interchange to Benton - Route markers, frontage road to Bell Road, SH 5 on frontage road.
	x	
	x	Exception: "STOP" sign, frontage road intersection with a side street.
x		"YIELD" signs particularly and one "STOP" sign on west frontage road.

Question: Does there appear to be an excessive amount of informational signing within the right-of-way?

Answer: Yes, Possibly, No

<u>Y</u>	<u>P</u>	<u>N</u>	<u>Comments</u>
x			"MERGING TRAFFIC" signs appear to be extraneous. "NO STOPPING EXCEPT FOR REPAIRS" and "YIELD" signs on ramps are unnecessary.
		x	More is needed.
		x	More needed and messages need reworking to be meaningful.
		x	Except for 70-C on I-30.
		x	
		x	
		x	

Question: Is the informational signing provided of real value to a majority of the traffic?

Answer: Yes, Possibly, No

<u>Yes</u>	<u>P</u>	<u>N</u>	<u>Comments</u>
x			
x			
		x	The signing does not agree with the physical geometric features and is misleading.
x			
x			
x			
			Probably not - Example: Route 5 North.

Question: In your opinion, the roadside advertising in this section competes with the traffic control devices for the driver's attention to:

Answer: (A) A marked degree, (B) Some degree, (C) A limited degree, (D) A very limited degree, if at all

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>Comments</u>
		x		
	x			Bright flashing commercial beacon type sign was distracting. One "YIELD" sign on frontage road was hidden by background of lighting on commercial sign.
x				
x		x		A marked degree on frontage road - a limited degree on main lanes.
		x		On frontage road competition is noticeable - not on main lanes.
			x	
x				Advertising stands out, way above highway signs.

SUMMARY OF DIAGNOSTIC QUESTIONNAIRE

PILOT SITE 2 I-30 BENTON, ARKANSAS

Question: Are the points of divergency from the traffic stream (ramps and/or turning roadways) obvious to the normally alert driver a sufficient time in advance of the necessary maneuver such that a smooth, natural transition to the diverging roadway is possible?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
		x	Generally adequate except southbound exit south of Saline River and northbound exit to U.S. 70C (Sevier Road).
	x		Exits from interstate were satisfactory. Ramp-frontage road connections were difficult to see.
		x	Needs better delineation, and the advance sign with arrow needs to be nearer the point of action - several off-ramps need deceleration lanes.
		x	But illumination tends to make it better than during day hours.
		x	OK for divergence from main lanes - not so obvious on frontage roads and ramp junctions.
		x	Westbound at state hospital especially tricky at night. Other points along the frontage road, especially when entering the freeway were also confusing.
		x	

Question: The fixed illumination provides a view of the road which is -

Answer: (1) about the same as daylight conditions, (2) somewhat less than daylight conditions but adequate to discern the various roadway elements, (3) adequate to illuminate the through lanes but the ramps and/or turning roadways are not as visible as they should be, (4) inadequate for safe driving.

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>Comments</u>
		x		
		x		
		x		The lamps need maintenance - several outages.
	x			
		x		
	x			Illumination was spotty on main line and very confusing to frontage road operation
				Lighting is consistent with what we use but need improvement.

Question: Does the glare from opposing headlights and/or the roadway lighting tend to obscure the driver's view of the roadway ahead?

Answer: (A) Probably, (B) Possibly, (C) Not to any marked degree

<u>A</u>	<u>B</u>	<u>C</u>	<u>Comments</u>
x			Yes - Particularly bad on frontage road.
x			Lights from opposing traffic on the two-way frontage roads (while driving on the main lanes) were distracting although they did not obscure the view.
	x		Especially with two-way traffic on the frontage roads.
		x	
x			Glare noticeable from cars on ramps when auto lights directed toward main lanes.
x			On the frontage road especially.
x			Two-way frontage roads make this particularly bad.

Question: Does the fixed illumination at this site eliminate the need for special roadway delineation (roadside delineators, pavement edge lines, etc.)?

<u>Answer:</u>	<u>Yes</u>	<u>Possibly</u>	<u>No</u>	<u>Comments</u>
			x	
			x	Edge striping is considered unnecessary; ramp delineators are of value.
			x	Need edge lines due to traffic on frontage roads. Delineations - yes - but retain edge lines.
			x	Delineation at ramp terminals still desirable. Lighting reduces the effectiveness of edge stripe; however, the edge stripe was worn and might have shown up better if new.
			x	This road needs all the help it can get. No edge line on most of frontage road. Main line is possibly adequate.
			x	Ramps and speed change lanes should have roadside delineators.

Question: Does the location of the roadway signs, with respect to the luminaires, make them difficult to read at a glance?

Answer: Yes, In some cases, No

<u>Yes</u>	<u>ISC</u>	<u>No</u>	<u>Comments</u>
	x		
		x	
	x		Some behind poles.
		x	
		x	
x			Main line is no particular problem, but frontage road is. Cross illumination creates an interference glare. Worts Motel is a good example. Any signing here is under adverse conditions.
x			

Question: In your opinion, would varying the color of the luminaires in merging and diverging areas assist in the delineation of these areas?

<u>Answer:</u>	<u>Yes</u>	<u>Possibly</u>	<u>No</u>	<u>Comments</u>
			x	An increase in footcandles throughout would help delineation.
			x	
			x	
				Not color of light but possibly color of pole.
		x		
			x	Adequate uniform lighting would be best.
		x		
			x	Not under present lighting conditions; color contrast without considerable additional illumination would be difficult to achieve.
			x	
			x	
				<u>Not blue!</u> Possibly yellow.
		x		It would be more helpful for diverging areas.
			x	There is no problem here when these areas are obvious. Any type edge marking would be satisfactory.
		x		

Question: In your opinion, the sight distance to right-of-way control devices with the existing illumination is:

Answer: (A) Adequate, (Q) Questionable, (I) Inadequate, (C) Critical

<u>A</u>	<u>Q</u>	<u>I</u>	<u>C</u>	<u>Comments</u>
x		x		Adequate - main lanes, Inadequate - frontage road, x-road connections.
		x		Some signs were located outside the headlight.
		x		

<u>A</u>	<u>Q</u>	<u>I</u>	<u>C</u>	<u>Comments</u>
x				Some dark spots but does not limit visibility to signs, etc.
	x			
		x		Again, glare considerations limit effectiveness.
	x			

Question: Where hazard warnings are provided, can they be easily associated with the hazard involved?

<u>Answer:</u>	<u>Yes</u>	<u>No</u>	<u>Comments</u>
		x	Hazard warning alone, without advance delineation, results in driver discomfort.
	x		
	x		Numerous hazards have no warning.
	x		
	x		
	x		
	x		

Question: Do signs and lights outside the right-of-way detract to a marked degree from the effectiveness of traffic control devices?

<u>Answer:</u>	<u>Yes</u>	<u>Possibly</u>	<u>No</u>	<u>Comments</u>
	x			
		x		While operating on frontage roads.
	x			Some - real eye-catchers (e.g., flashers and radiators).
		x		Not on the main lanes, possibly on frontage road.
		x		Decrease comfort of driver if nothing else.
	x			Very much so.

APPENDIX "C"

SUMMARY OF TECHNICAL INTERVIEWS

PILOT SITE 2 I-30 BENTON, ARKANSAS

TWO-WAY FRONTAGE ROADS

DAY PHASE

I have to take a deep breath every time I cross one of these (on frontage road passing slip ramp terminal opposing ramp traffic).

I had trouble with the turn at the Sevier Street Interchange (from the north frontage onto the structure). I thought there would be another connection. Maybe the trouble was the directional signing.

No sign telling which way to go (approaching Sevier Street Interchange on north frontage road eastbound).

There is considerable confusion as to direction on these roads (on south frontage road eastbound at the Hot Springs Interchange).

There is an obvious need for signing on the frontage road throughout the length of the study section.

There are no confirmatory markers for "I-30 BUSINESS" after you leave the freeway, until you are well down the road.

NIGHT PHASE

The traffic on the frontage road on the right does bother me on the curve (opposing headlights).

You lose the ramp but is not too bad (loop ramp on south side of Hot Springs Interchange).

The luminaire being out really hurts. I feel more cautious tonight. There are too many sources of headlight, the frontage road left and right, the main lanes, all direction.

In the day it is less noticeable, because it blends into the roadside development, whereas, at night, headlights and (the fixed) illumination outline the problem making it more apparent.

This frontage road has bad open frontage, no control of access.

The "STOP" sign at the intersection of SH 5 looks like it might be for us (on north frontage road westbound).

There are two extremely bright lights at the motel (north frontage road westbound) near Sevier Street Interchange.

The edge stripe might direct you right on into the main lanes, unless you were real observant.

The double yellow on the frontage road you can't see.

The sight distance on every interchange is far too short.

The flashing crystal light is very distracting (westbound on north frontage road at the rendezvous point).

The flashing light doesn't bother me. It's not really as bad as some (westbound) on north frontage road at the rendezvous point).

The flashing beacon adds to the competition for attention. At one point they are directly behind a "YIELD" sign.

That "STOP" sign looks like it is for me (on north frontage road westbound).

DAY PHASE

NIGHT PHASE

Did the Congo Road Exit have cardinal directions? Yes. (Exit from I-30 eastbound).

The driver missed the Sevier Street Interchange turn to I-30 Eastbound (on north frontage road eastbound).

SH 5 southbound does not have cardinal directions indicated on it.

They would be helpful.

The "YIELD" signs are too high and too small.

They should be replaced and remounted.

FREEWAY DESIGN

DAY PHASE

NIGHT PHASE

The on-ramp at the State Hospital Interchange terminates in a guard-rail. That is a real hazard.

The off-ramp (at the State Hospital Exit westbound) - well, I just could not tell where the deceleration lane was or even the ramp itself - poor contrast. I don't like these concrete deceleration lanes - not enough differentiation between main lanes and speed change lanes. Narrow bridge on Saline River Bridge is a critical safety problem.

FREEWAY SIGNING

DAY PHASE

NIGHT PHASE

There is no clearance given on the structures. I believe there should be.

Go eastbound! I don't know which direction we are going.

The paddle treatment at the State Hospital Exit is all right. You sure don't have trouble finding the exit.

Some of these signs could be attached to light poles and bridges as well as delineators and save sign posts.

The U.S. shields have better target value than the Interstate shields. Which is more important of the two?

There is little need for two signs, one with US-70 and the other with I-30.

I wish we could sign as well as they do (Esso, Shell, Texaco, etc.). They have good visibility and good driver recognition.

The Interstate shield is too small. These signs show up better than our highway signs (referring to commercial signing), and they are about 100 ft. off the roadway.

The Mobil sign is much brighter than highway signs.

DAY PHASE

NIGHT PHASE

The ramps are signed pretty much to Interstate standards; in between they are not. There should be some consistency on this type of road.

FREEWAY ILLUMINATION

DAY PHASE

NIGHT PHASE

An edge line is not necessary with the contrast that is present. However, if the pavement and shoulder were of the same material, then it would definitely be needed.

Going from light to dark, back to light is distracting, but I don't think the shadow and the light is any more distracting to me than to see the light coming at me. I think there should be a shield to cut the glare.
The fact that a luminaire is out doesn't bother driver - although he noticed it. There seems to be a lot of luminaires out.

POST-MOUNTED DELINEATORS

DAY PHASE

NIGHT PHASE

The delineators are not particularly effective (at night), maybe because of the mounting height.
The amber series (at the Alcoa Road Interchange) shows up well.

TIGHT LOOP RAMPS

DAY PHASE

NIGHT PHASE

PAVEMENT MARKINGS

DAY PHASE

NIGHT PHASE

The two pavement arrows on the off-ramps might mean two lanes ahead where there is only one.
The two pavement arrows on the off-ramp don't mean one-way traffic ahead to me. I would take it that this is a one-way ramp. Two lanes coming off? Maybe, but doubtful.

The edge lines are very effective here (outside of the lighted area), both on the left and right.
I don't think the edge striping is as effective in the lighted section as it was in the unlighted section.
The illumination washes out the edge line, and it is critical on these tight loops.

MISCELLANEOUS COMMENTS

DAY PHASE

This pavement is very rough for an Interstate Highway west of Saline River Bridge). It must be several years old.

NIGHT PHASE

Can you predict from the observation during the day what the problems will be at night? Definitely, NO! One of the considerations on this roadway is to correct some of the obvious sources of competition and glare. The pattern of light distribution does not favor the frontage road at all. With all the junkyard screening projects this would (referring to the study site and particularly the north frontage road) be a good candidate for a screening project.

APPENDIX "D"

SUMMARY OF NON TECHNICAL DRIVER INTERVIEWS

PILOT SITE 2 I-30 BENTON, ARKANSAS

DAY PHASE

Restricted sight distance on Sevier Street Interchange.
Signing on south frontage road at the Sevier Street Interchange is inadequate. I wasn't sure where I-30 BUSINESS or U.S. 70 went. I think it should have another sign backup at the "Y".
The entrance to I-30 east of the Congo Road Interchange is hard to find. No advance warning.
The only thing that tells me this is a two-way frontage road is the centerline. There is no signing to confirm it. Maybe a "TWO-WAY TRAFFIC AHEAD" sign on the ramp would be of value.
I had same problem coming off the access road to the Interstate. No actual sign telling how to get to the Interstate or indicating two-way operation. After leaving I-30 to Benton on U. S. 70, there were no confirmatory markers.
I like the sign that says "WRONG WAY" on exit ramps - it stands out real good.
Driver missed the Sevier Street Interchange ramp - did not see any sign (eastbound on north frontage road.)
The SH 5 north exits from I-30 eastbound are easy to find.
I would like to have a little more time to plan a turn (Sevier Street exit cited).
The frontage road should have a "STOP" sign rather than a "YIELD" sign at the terminal of the off-ramp (apparently referring to the opposing flow on the frontage road).

NIGHT PHASE

I had to stop at that "YIELD" sign (eastbound on north frontage road at Sevier Street exit ramp) to be sure it was safe. I just could not see.
The yellow striping is the only way to tell it is two-way.
The SH 5 exit is not clear and does not reflect well.
Some of the pavement markings are dim (on I-30 eastbound).
The edge line isn't too important for me. I tend to drive off the centerline rather than the edge line.
That sign could have been posted sooner for that turn. (I-30 on ramp just east of Congo Road Interchange.)
Do you know what the delineators with the two little dots on it mean? - and sometimes three dots? I have no idea!
I had trouble finding the exit ramp with my dim lights on (Alcoa Road).
When there is a car in the northbound lane and one on the frontage road, it is distracting to me.
This lighting bothers me. There is a reflection off the dash.
As a point when the lights just go out of (my) line of vision, there is glare but it isn't too bad.
These lane markings (presumably the edge line also) are less visible at night, a lot of bad shadows.
That ramp could be clearer, but I can tell where the road goes (Sevier Street exit ramp westbound).
The illumination did not affect me adversely exactly, but I did notice a good deal of glare.
I did not notice any particular commercial signing that was too distracting.
The arrow on the I-30 BUSINESS advance warning sign created comment, "I THOUGHT THAT I WOULD BE TURNING BEFORE I DID."
It is very hard to see coming out of the illumination.
The confirmatory markers on I-30 BUSINESS are not reflectorized and are hard to see.

DAY PHASE

NIGHT PHASE

The only time the lights really bother me is when I leave the light for the dark.

One of the things that really bothered me was the absence of light just going into a curve (apparently referring to tight loop ramps)*; some of the signs were not reflectorized and were hard to see.